CLAIMS

I claim:

1. An improved CZ system for growing a single crystal ingot from a molten crystalline material comprising:

a low aspect ratio, wide diameter crucible including a base and side walls for holding a quantity of molten material at a melt / crystal interface with respect to a seed crystal for growing an ingot from the molten material;

a pre melter for providing a continuous source of molten material to the crucible, such that the melt /crystal interface is maintained at a desired level without vertical travel of the crucible;

annular heating means disposed adjacent to the base of the crucible for providing a uniform thermal distribution across the melt and at the crystal melt interface for optimal crystal growth .

2. An improved CZ system as in claim 1 wherein the annular heating means comprise a plurality of separately controlled resistive heaters disposed in a radial pattern to establish corresponding thermal zones across the melt, each thermal zone controlled by thermal output of a respective resistive heater such that an optimal thermal distribution is established across the melt and at the crystal melt interface.

3. An improved CZ system as in claim 2, further comprising one or more individually controlled side wall heaters and one or more sensors for monitoring temperature of each thermal zone and for producing signals representative of sensed temperature;

control means responsive to the sensor signals for activating each side wall heater and annular heating means such that an optimal thermal distribution is established across the melt and at the crystal melt interface.

4. An improved CZ system as in claim 1 comprising means for adding dopant as needed to the pre melter during crystal growth to provide compensation for segregation and establish a substantially uniform dopant concentration in the grown crystal.

5. An improved CZ grower as in claim 1 further comprising a plurality of crystal pull chambers sequentially disposed with respect to the crucible, each pull chamber including means for positioning a seed crystal at the melt / crystal interface and for pulling the growing ingot, such that upon completion of growth of a first ingot, a first pull chamber moves the first ingot away from the crucible for cooling, and a successive pull chamber moves to position a new crystal at the crystal / melt interface in the crucible.

6. An improved CZ system according to claim 1 wherein the low aspect ratio (diameter with respect to height) of the crucible is in a range of 4:1 to 10:1 and preferably about 8:1.

7. A system for continuous growth of a single crystal ingot as in claim 1 further comprising a means for adding amounts of dopant material to the pre melter such that a dopant concentration gradient throughout the ingot is substantially uniform.

8. A system for continuous growth of a single crystal ingot comprising:

a low aspect ratio, large diameter crucible including a base for holding a melt of crystalline material ;

a pre-melter having an inlet for receiving a supply of crystalline material, a means for melting the material, and an outlet communicating with the crucible for replenishing the melt as it is taken up by the growing crystal, such that the melt in the crucible is maintained at a desired level with respect to the crystal, without vertical travel of the crucible;

multiple crystal pull chambers sequentially disposed with respect to the crucible such that upon growth of a first ingot, a first pull chamber moves the first ingot out of the away crucible for cooling, and a successive pull chamber moves to position a new crystal in the crucible;

individually controllable heating means disposed adjacent to the base of the crucible for providing an optimal thermal distribution across the melt and at the crystal melt interface for improved crystal growth .

9. A system for continuous growth of a single crystal ingot as in claim 8 further comprising a means for adding precise amounts of dopant material as needed to the pre melter such that an axial, (lengthwise), electrical conductivity gradient of the ingot is substantailly uniform.

10. A system for continuous growth of a single crystal ingot as in claim 8 further comprising a weir disposed in the melt between the crystal /melt interface and outlet port of the pre-melter; the weir including a top surface extending above the melt to block formation of ripples or thermal perturbations in the melt as molten material from the pre-melter is distributed into the melt.

11. An improved CZ system for growing a single crystal ingot from a molten crystalline material comprising:

a low aspect ratio, wide diameter crucible for holding a quantity of molten material at a melt / crystal interface with respect to a seed crystal for growing an ingot from the molten material;

a pre melter for receiving a source of solid crystalline material and dopant material and providing a continuous source of molten doped material to the crucible;

individually controllable heating means disposed around the sides and adjacent to the base of the crucible for providing an optimal thermal distribution across the melt and at the crystal melt interface for improved crystal growth .

12. In a CZ system for growing a single crystal ingot from a molten crystalline material, the improvement comprising:

a low aspect ratio, wide diameter crucible for containing the molten material, the crucible comprising a material selected from the group consisting of: alpha or beta sintered silicon carbide, or similar ceramic.

13. In a CZ system for growing a single crystal ingot from a molten crystalline material, the improvement comprising:

a low aspect ratio, wide diameter crucible having interior surfaces for containing the molten material coated with a material selected from the group consisting of: alpha or beta sintered silicon carbide, tantalum nitride, or similar ceramic.

14. An improved CZ system for growing an ingot from a seed crystal positioned at a growth interface in a crucible including a pre melter for melting solid crystalline feedstock received from a source and for and providing an output of molten material to the crucible, comprising;

a load cell means for sensing the weight of the melt in the crucible and for producing output signals representative of the sensed weight;

a level controller comprising a microprocessor responsive to signals from the load cell and for determining output of the pre melter based on a desired depth D of melt in the growth crucible

a flow control means, communicatively linked with the level controller and disposed between the source of solid feedstock and the pre melter for truncating or dispensing feedstock from the source to the pre melter in response to a signal from the level controller such that the output of the pre melter maintains the level of melt in the crucible at a predetermined depth for optimal crystal growth

15. A process for improved growth of a single crystal ingot from a seed crystal positioned at a crystal / melt interface in a molten crystalline material comprising:

containing the molten material in a low aspect ratio, wide diameter crucible for reducing convection currents and vertical thermal variations in the melt;

melting solid crystalline material in a pre melter for providing a continuous output of molten material to the crucible for maintaining the crystal / melt interface at a desired level in the crucible;

providing a plurality of heaters beneath the crucible for establishing a plurality of corresponding thermal zones across the melt;

controlling the thermal output of the heaters for providing an optimal thermal distribution across the melt and at the crystal / melt interface for improved crystal growth .

16. A process according to claim 15 wherein the step of providing a continuous source of molten material to the crucible for maintaining the crystal / melt interface at a desired level further comprises:

determining the weight of the crucible both empty and with a desired level of melt;

determining output of the pre melter based on a desired depth of melt in the growth crucible;

sensing the weight of the growth crucible during crystal growth; and actuating a dispenser for controlling release of a predetermined amount of solid crystalline feedstock into the pre melter to maintain the desired depth of melt in the crucible.

17. An improved single crystal material characterized by high minority carrier lifetime, made by the process comprising:

growing the single crystal material from a seed crystal held at a crystal melt interface in a wide diameter, low aspect ratio crucible for preventing formation of convection currents and minimizing oxygen in the melt;

melting the crystalline material in a pre melter for perturbation free replenishment of the melt in the crucible ;

providing a plurality of individually controllable thermal zones across the melt; such that an optimal thermal distribution is created across the melt, and particularly at the melt crystal interface .